OPINION

Regarding a dissertation thesis
for the acquisition of the educational and scientific degree "Doctor"

In the field of higher education – 5. "Technical Sciences"
professional field – 5.3. "Communication and Computer Engineering"
doctoral program – "Automation of engineering activities and automatic design systems"

Author of the dissertation thesis: Mag. Eng. Ilian Tsvyatkov Varbov
Topic of the dissertation thesis: "MODELING AND SIMULATION OF COMPONENTS OF COMPUTER SYSTEMS"
Member of the scientific jury: Assoc. Prof. Dr. Eng. Krassimir Iliev Kolev

1. Topic and Relevance of the Dissertation Thesis

The present dissertation is dedicated to the modeling and simulation of core components of computer systems. The study emphasizes the creation of functional and synthesizable models to be used for education and analysis, as well as for practical implementation on an FPGA platform. The development of field-programmable gate arrays (FPGA) provides an environment for rapid prototyping and experimentation with various architectural solutions. The significance of research in the field of modeling and simulation of computer systems is linked to the increasing requirements for hardware optimization and the need to integrate new architectures. The creation of universal, scalable, and modular models of basic functional blocks supports both academic research and practical developments in industry and makes the design process more flexible. The main goal of the dissertation is to develop and analyze models of core components of computer systems using modern hardware description languages and simulation environments, and to create and implement an AVR architecture microprocessor model on an FPGA platform. The object of the research is the processes of modeling and simulation of hardware components of computer systems. The subject of the research is the methods and language tools used to create models of functional blocks and microprocessor architectures, as well as their practical realization on FPGA platforms. The author's models complement existing developments by emphasizing education, analysis, and comparison of different modeling approaches.

The modeling of the core components of computer systems is a key stage in the design and verification process of digital devices. Through it, the functionality of individual blocks is investigated and their operability is verified before hardware implementation. The dissertation thesis considers problems related to the modeling and simulation of computer system components that are significant for modern prototyping technologies of reconfigurable digital devices. The relevance of the research is also determined by the need to develop verified models suitable for applications in various industrial and scientific fields. Therefore, the dissertation thesis has a significant contribution not only in theoretical but also in practical aspects, providing solutions for modeling core computer system components in various hardware description languages (HDL).

2. Research Methodology

The dissertation thesis is structured into four chapters, each of which considers a different aspect of the research. The dissertation thesis contains an introduction, four chapters, a conclusion, a bibliography, and two appendices, with a total volume of 197 pages.

In the dissertation thesis, a targeted methodological approach has been applied, including analysis of existing methods, development of models and algorithms, as well as their experimental

evaluation. Modern methods for functional and simulation modeling, register-level modeling, and computer simulation were used in the dissertation. The verification of the developed models of computer system components is realized through specialized software. For the realization of the dissertation, empirical methods such as analysis of publications, documents, and results of other scientists were used, and a literature review was conducted – a mandatory part of every scientific development. During the development of the proposed models, theoretical methods of analysis and synthesis were used, accompanied by comparisons of the capabilities of each model. The constituent parts and processes of computer systems, as well as the interactions between them, have been identified; specific characteristics and qualities have been identified. Various elements and aspects of the research object are combined into a complete system. A comparison of objects for their similarities and differences has been made. Formalization was performed by presenting conceptual knowledge in the form of operators and through the HDL artificial language for describing structures. An analogy was performed in which knowledge from one object (obtained by examining a given model) is transferred to another object (called a prototype). The realized models are an object selected and transformed for cognitive purposes. The realized structures allow for obtaining new data about the corresponding primary object based on proven scientific methods of knowledge.

3. Contributions of the Dissertation Thesis

The doctoral student has formulated a total of six contributions, which are not divided into categories:

1. Created models of core digital components of computer systems – arithmetic logic units, random access memory, multiplexers, demultiplexers, encoders, decoders, counters, registers, and comparators – implemented via the hardware description languages VHDL and Verilog.
2. Developed RISC architecture microprocessor models based on the hardware description languages TL-Verilog, Verilog, and VHDL. Through these models, the organization and interaction between the main blocks – arithmetic logic unit, register file, memory, and control block – have been investigated.
3. Developed an AVR architecture microprocessor model at the register level.
4. Implemented an AVR architecture microprocessor model on an FPGA platform.
5. Evaluated performance and resource efficiency of HDL models upon FPGA implementation, which can be used for the optimization of future projects.
6. Conducted a comparative analysis of existing developments and the proposed RISC and AVR microprocessor models.

I accept the contributions declared and formulated by the doctoral student. In my opinion, the contributions should be considered and divided into categories such as scientific-applied and applied contributions. The developed models and proposed solutions represent a significant contribution to the improvement of existing approaches in the field of computer systems.

4. Publications and Citations on the Dissertation Thesis

The results of the dissertation thesis are published in a total of 7 scientific publications, which testifies to recognition in the scientific community. The doctoral student has a solo publication, and in the others, he is the first author. One of the publications is indexed in international databases, such as Scopus, which shows the high level of approbation of the research. The total number of points from publication activity is 60 out of the required 30. The publications present the main research from the dissertation thesis. The overall scientific work and the doctoral student's publications demonstrate in-depth knowledge and understanding of the dissertation's topic, as well as the author's ability to formulate and solve current scientific-applied tasks. I believe these publications contain the main author's contributions claimed in the dissertation. This corresponds to

the requirements of the Law on the Development of the Academic Staff and the Regulations for its application regarding the publication of the most essential parts of the dissertation thesis. There is no information in the attached documents regarding citations of the presented publications of the doctoral student.

5. Authorship of the Obtained Results

In the presentation of the dissertation thesis, a significant volume of research and experimental activity was realized by the doctoral student under the guidance of his scientific supervisor. In the text, the doctoral student's own contributions are clearly distinguished from the existing methods and approaches used. I believe that the main part of the conducted research and analysis of the results is entirely the personal contribution of the doctoral student. The developed models and the obtained results demonstrate a high degree of originality and depth in the field of computer systems. The obtained results are analyzed in detail and supported by logical conclusions, which proves their validity and reliability. The work demonstrates a high level of competence and commitment to scientific research, highlighting the significance of the results obtained by the doctoral student in his scientific field.

6. Opinions, Recommendations, and Remarks on the Dissertation Thesis

The dissertation thesis is logically structured and presents an in-depth analysis of the issues under consideration. The methodology is well-founded, and the results obtained are clearly argued and supported by analyses and conclusions. I recommend continuing scientific research to create new models in the field of reconfigurable computer systems. The doctoral student could focus more on publishing in prestigious peer-reviewed journals abroad. I have no significant remarks regarding the content of the work. In future developments, the author may expand the applicability of the proposed models by testing them on different FPGAs.

7. Conclusion

The topic of the dissertation thesis is contemporary and useful for the design and verification of computer system elements. The presented issues and related research, as well as their justification, are comprehensively described. The dissertation thesis achieves its stated goal, the defined tasks are completed, and the dissertation has a finished character. Corresponding conclusions have been made, which gives me reason to assess that the dissertation thesis has the necessary scientific-applied and applied contributions. The research and the obtained results are sufficient for the educational and scientific degree "Doctor".

I believe that the presented dissertation thesis meets the requirements of the Law on the Development of the Academic Staff in the Republic of Bulgaria. The results achieved give me reason to propose that the educational and scientific degree "Doctor" be acquired by Mag. Eng. Ilian Tsvyatkov Varbov in the field of higher education – 5. "Technical Sciences", professional field – 5.3. "Communication and Computer Engineering", doctoral program "Automation of engineering activities and automatic design systems ".

April 20, 2026
Member of the Scientific Jury: ……
(Assoc. Prof. Dr. Eng. Krassimir Kolev)